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An Inaugural Essay

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very good

Circulation of the Blood.

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by

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of

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There are few subjects in Physiology, less understood than the circulation of the blood; from the intricacy of its movement through the capillary and venous systems, it seems to have eluded the researches of science, and most of the theories formed on it, and disseminated in the schools, are based more upon conjecture than observation: hence it becomes a proper subject for examination, how far these different views are founded on reason and fact, and to what extent we may select matter from the various conflicting opinions to arrive at the truth.-

Bichat being the most prominent amongst those who have enriched Medical science in this, or any other age, I shall freely draw from his invaluable stores, as the best repository of knowledge; indeed it is my intention to do little more than follow in the path already beaten by this great luminary, and by canvassing whatever starts up, that may appear not clearly elucidated, I can at least hope to become acquainted with his principles and inestimable facts; it is not the province of a

student, to seize boldly on the helm of discovery, and steer through the quicksands of error, or amid the dark delusions that attend even the most skilful: this belongs undoubtedly to the practised mind of the physician: it requires knowledge, ample experience, and the nicest tact; the perseverance of a Morgagni, or the genius of a Hunter. But by examining, with due deference their theories, to acquire a habit of thinking boldly, of concluding correctly, and deciding justly, is certainly within the limits of his capacity, and his imperative duty. — Impressed with these views, I have rejected the dubious chance, of experimenting with an unskilful eye, and deficient apparatus, for the less brilliant prospect, of following an author through his own discoveries, and offering my feeble comments upon them.

The circulation of the blood, since the time of its discoverer, Harvey, has engaged the close study of every physiologist: and with so much labour already bestowed upon it, with so little success, may be supposed to possess no little intricacy. Notwithstanding the streams of latent

which have flowed upon it in modern times, the most important and vital phenomena of its movement, remain yet undiscovered. The mysterious return of its columns to the heart, the offices which it apparently performs of, nutrition, exhalation, and absorption, and the deeply hidden objects of the abdominal circulation, are explained only on conjectural hypotheses and contradictory theories. It is reserved for a future Hunter or Bichat, to elucidate these knotty subjects, and perhaps effect a great and final revolution in our science: until then we must be content to speculate, with our, yet imperfect and broken chain of explanations.

The circulation is divided by Bichat into two kinds: viz. that of the red and black blood, the limits of each, being the pulmonary and general capillaries: the first or that of the red blood, commences in the extreme vessels, ramifying on the air cells of the lungs, which collecting into branches, and these again into trunks, it is discharged by four veins into the left auricle of the heart; thence it passes into the left ventricle and is distributed by its contraction through the aorta and

its branches, to the general capillaries; the route in this circulation of the blood, resembles radii proceeding from the superficies to the centre, and thence to an opposite and similar surface, or in other words, it forms two cones, joined together at their apices: at this place of junction, is situated the efficient organ of all its movements, the heart; this, being possessed of an apparatus for propelling the contained column, by its contraction forces the blood into the arteries, and through them, to the capillaries: it is supposed also, by many to facilitate the return of the pulmonary blood by its dilatation.

This movement, however, simple as it may at first appear, is the subject of many theories, opposite in character, and of high pretensions. Harvey, and the mechanicians, referred it altogether to the heart, and consequently considered the arteries as passive tubes: Hunter, and most modern writers give these latter the attributes of muscularity, and make them serve materially in the motion of the blood, whilst Bichat, depriving them of muscular structure, considers their contraction only the effect of texture, and gives them a middle station. Unprepared

a Middle, which he considers, elastic and muscular. The latter or muscular lamina with its fibres. In this or muscular coat, we endeavored to operate in the subject of contraction of an artery: to determine how far this structure connected with the muscular tube, if left to itself would dilate, and from the dilatation cause the division of internal arteries, how did not return to their original dimensions: how often dilated after death to not return to their dimensions: a muscle once stretched after death to not return to its exertion at all: but according to our results the artery was reached to nearly its original diameter: a tube of elastic body loses nothing of its elasticity by contraction and we arrived at the conclusion that the contraction was the muscular lamina of the middle coat and that it was of greater elasticity to the internal or muscular fibres of the artery that in a section of the aorta, the elastic lamina muscular, lamina - epithelial, in the middle tunic of the arteries, describes it as a peculiar tissue

[illegible] fibrous [illegible], [illegible] to [illegible] ar. [illegible] muscular fibre, which are capable of [illegible] to a certain extent, but beyond this, are [illegible] the [illegible] and [illegible], [illegible] simply, [illegible], [illegible]. Here [illegible] in [illegible] an interstitial [illegible] [illegible] I am [illegible] but that the [illegible] [illegible] in some measure over [illegible] I think [illegible] a [illegible] to prove. The [illegible] certainly show, what must be the fact that [illegible] are not perfectly elastic; but do they [illegible] that the muscular fibre is present? & even [illegible] acknowledges that he "never could discover the [illegible] of the muscular fibres." According to Dr. Jackson [illegible] [illegible] able to detect fibres in this [illegible] [illegible] [illegible] [illegible] further [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] it [illegible]. [illegible]

power in talk. On the same principle is Mr. Bunker, which consists in taking a section of the work, may readily appear conceive. When at a minimum state of contraction, the coil or rotary is rather more projected beyond the other; but when the iron and Hebbert brushes body and the coil, the machine coal project.

In according experiments I consider with performance on the shaft and rotary brush the upper part of the coil and shaft of the coil, then the work the machine Bunker and the machine at the other round from the work; Spain a shaft of the coil, whose other in a machine, the part is detachable under. I of the machine coil is the work and the coil, when on the coil, I into the pin, and according in the part is detached from. This will remain small in the case of electrical the machine only the result the last upon Michael on the members I use the "Upon." The part of the frontier machine I the interior is very evident in the great

The second, or peculiar coat of the heart, is a membrane, often called different on its principal from the [illegible] surface the heart or the cavity in the [illegible] of a heart, character to the [illegible] of those who assist in blood, and experience, not [illegible] of distention only to the limit of the [illegible] or internal coat is thin and furnishes a smooth and lubricated surface for the passage of the blood. According to Bichat, this is the seat of affections, but the majority of anatomists consider this affections as located in the middle coat. Until by the aspect a set of epithelial cells, capable of [illegible] this point beyond which the two internal coats must rupture.

Hence, we arrive at the conclusion, that the heart by its contraction, throws the blood into the aorta, which is guarded by the semilunar valves. Now the mechanism of this function is evident to this: considering the blood as a liquid almost inelastic, it must follow, that when by its force the arteries shall have dilated to their maximum, the remainder must enter the capillaries with the same velocity

cæteris paribus, as that which moves in the aorta; the sum of the areas of the extreme branches however, is greater than that of the aorta; hence the blood will circulate slower in them than in the aorta, and this coincides with the phenomena of Spallanzani. — I consider the blood as an almost incompressible fluid; some of that little is required to comply with, for its compression, is scarcely worth mentioning; the minute vessels, as the blood does not cease to flow in an elastic tube, is because of the elasticity or contractility of the vessels; this being stretched to its maximum point, by the first portion of the blood, it follows, that the remainder must by the same cause, that a liquid would in a recurring a solid piston, or in other words, that through two columns of equal diameter in any part of the body it will pass with the same velocity.

From the known principle of hydrostatics, that a fluid will not pass beyond an angle in the same vessel, with the same velocity with which it first moved, it has been thought that the arteries should become less in diameter with

each turn: and according as one or the other part of the work
exhibited as a vase in front: thus with the use, at the com-
pariet, a vase time evolved it in succession, one the con-
tains arrived at are detached from the central cylinder.

Mr. au open tube, the sides of which in ornamental figure
the first jet of liquid, will ascend, & retain its position
angle: but if this tube be conch-shell filled with sand
ascends above at one end; the sand in the tube will
ascend, will fall from the other end: thus
in same ratio, as taken by one of the two sand
was supplied by the other: & machine
a perfect shape while it was at rest, the same being
behind, as shall appear in succession by but as
is a globule thus situated, friction on its
takes the round. Hence the alternation in
also in order such circumstances: all the com-
bination to be moveable when, and elevated with some
instant of rest: whereon the same ends: some
in the cylinder was next the same succession closed

in a slight degree upon its contents, from the contractility of
texture; the first jet of blood dilates it to the point, beyond
which it cannot go, and then the force & velocity are nearly
uniform throughout. — Considering the column as a column
[illegible]
the arteries, but this occurs only in the commencement of the
systole, and before the tube is fixed by having attained its extreme
limit of dilatation. — Admitting these considerations to be correct
we have no need of these dilatations beyond such curve as
admits of the blood will pass as well, may, better, without
them. If the blood move, as I have stated, the count of
dilatations can have no influence on its velocity, and consequently
as the surface of the artery is extended, it will have a tendency
to rupture, exactly on the principles of a hydrostatic
bellows. If the artery be dilated to twice its natural size,
without a proportionable increase of thickness, there will be
at least 4 times the pressure originally sustained; thus,
that tube although dilatations exist, and without an increase
of particles the pressure would be increased with the cur

[illegible] you cannot distinguish [illegible] the thickness of the sanguineous column, & its non-elastic particles, would subject it to the same laws; the liquid moves simultaneously in all its parts, when confined to a regular cylinder. It is very true that the aorta possesses, especially in old subjects, a considerable dilatation at its great curve; but, if the preparations I have examined, are to be relied on, this dilatation does not correspond with what it ought to exhibit, were its object as stated in the preceding theory. In an angular tube, the increased circumference should be just beyond the bend, because the impediment exists at its extreme boundary, and until the liquid has reached that impediment it loses but little of its momentum. This however does not hold in the aorta, for the dilatation exists immediately in its curve, and is lost even before that curve is completed. How then can this dilatation facilitate the passage of the blood? that it does, is evident, or it would not exist. Look at the innominata, the

the left carotid, and subclavian arising from its upper portion;
is it not designed for the easier transmission of the blood into
those vessels? This is the use I would assign to it, and
since the only object it can be calculated to fulfil.

If the position I have attempted to disprove be true, certain
it is that dilatation should exist in the carotid artery, which makes
no less than six great curves before it gets into the cranium;
yet I have seen a dilatation in which this dilata-
tion was entirely evident. I shall however retain the position
I have assumed more firmly still, by reference to
the experiments of Spallanzani. In the 91st. exp^t., he found
that in the minimum artery the motion of the blood "was the
same, whatever might be the angle, formed by these vessels."
Experiment 61st. "The blood circulated with its usual velocity in
an intestinal vein, although it had 23 curvatures." These ex-
periments furnish collateral evidence to shew the non existence
of dilatation, otherwise the blood could not have flowed with
such velocity.

Hewson took the position, which Bichat so stren-

mently recurs. viz. that the blood has a simultaneous movement throughout the vessels, and the pulse, not only by its own, but gallvanic alternations, and as a consequence, the curvilinear angles of the arteries, have an effect, a tendency to circumscribe forces. Also. that the elastic tissue of the arteries, contrac ing by its own internal & vital or, if you be, mechanical powerties, when each diastole of the heart, must necessarily be again restored to their maximum limit of dilatation, by the next action & systole. but dilatation taken place immediately thereupon. the maximum point dilatation, is that point where the circular fibres & the middle tunic are brought to their stretch, or in other words, is a succession of cords upon an elastic tube until limit its dilatation, so these circular fibres act upon the tube. Whether observes that the circular fibres diminish as they approach the branches of the arterial trees. Thereby become their use in the structure & to contract to the minimum quantity required.

As regards the dilatation of arteries, Whether it think has settled the point, that the pulse, instead by the contraction

a new Input that would be similar and in the
same manner Our argument, to prove this position, that
States, that the actions of one could never act the part,
for if it did not, that universal and simultaneous effect to
cause that Input would not take place: the other would
run in undertow perpendicular to the force but not the
motion of the rest and in short the intention in
a word before the extreme arteries. This run is not
the rest. very subtle the run is not all the
one moment but it is done. Hence the first trans-
ide the effect was and would the members be that
what was bound in rule: but the shadow of the story,
a scrap from to do with the motion, it is static, for
that changeth the intention with position to some the
same. Then the spirit of the wine of subject of this
in, we should correct but the instruction of the three.
And Richat proved to since Apollo, in order and a vein
and when the head of a bone, crystals tinged in
other. nothing could be felt in the vein, but a kind of

resulting, whilst the artery pulsates as usual. The best illustration we can have of the arteries in situ, is afforded by a leaden pipe of a hydrant, which may run uncovered in a tortuous direction. Here, if the stream be permitted to flow, & then suddenly stopped by means of the cock, which will answer to the blow given the column by the heart, we perceive a quick locomotive effort, corresponding exactly to the undulation of the arteries. It is on this principle that the pulsation of the heart against the ribs can be accounted for, & on no other so satisfactorily.

When [illegible] the blood next enters the capillary system: and at this [illegible] we have the rest of the second sphygmus: the mechanism [illegible] in the circulations: an opinion by no means the least plausible, formerly existed, & has been revived in France, that the dilatations of the middle coat [illegible] in the formation of [illegible] formed. Whatever value we may attach to the arguments in its favour, it cannot explain the various [illegible]

...t this will be demonstrated. That mere mechanical laws will not solve the difficulties which encounter us here is evident: that theory that we possess, will on rational principles, and with admitted truths, explain to us, why the blood which until birth had passed from the pulmonary artery into the ductus venosus, at that period ceases to flow in its former channel, although an avenue is still open, and the vis-a-tergo more than sufficient to propel blood into it? This, among many of a similar nature will demonstrate the utter futility of the theory by which we explain the mechanical theories.

It is the opinion of Bichat, that the blood has an oscillatory movement given it in the capillaries; but such a motion appears very inadequate to the effect designed: When we consider the structure of the veins, and their valves, may we not attribute some of the capillary phenomena to a similar construction. I must confess, I am rather sceptical, on the general uses of the venous valves: that they have some other use besides supporting the column of blood merely, I think may be safely concluded: and if they extend to the capillaries

along with the venous fibres, I think some future day will assign a more probable use than is generally attributed to them.

These latter, viz: the venous fibres, run in a longitudinal direction: I have already endeavoured to shew that the arterial, exert their influence in resisting the great lateral pressure of the blood, which is beyond all comparison greater than the vertical, inasmuch as the lateral surface is of much more extent, than that of the ends of the arteries: reasoning from analogy, we should suppose that the venous fibres resisted the longitudinal stretching of the veins: this however cannot be since the force in that direction is very small: may they not then have some influence in the motion of the blood? It appears to me more probable, than the oscillatory movement of Bichat.

Dr. Jackson alledges, from microscopical observation, that the minute or extreme circulation is not performed in vessels: unless we consider the whole frame, as a series of convoluted vessels, we cannot, without this fact before us, believe in the omnipresence of the fluids: and with it the pathology of disease is intelligible and rational: yet it is certain that the

venous capillaries must have a commencement, which he thinks is in cul de sacs. This however, though doubtless correct, is but the connecting link: and without a cause of motion to the venous blood, the chain of explanation is far from being complete: whether it be from capillary attraction, oscillatory movement, muscular contraction, or some other power is yet to be determined. But the rapid march of Science, and the fresh discoveries continually breaking in upon her clouds of Error and Ignorance, lead me to hope, that this with many other unravelled intricacies, will, ere long be plucked from among the arcana of Nature, and added to the well earned laurels of Medicine.—